

**The Role of Transcranial Doppler in Assessing Short-term Prognosis of Non-fatal Ischemic Stroke**Daryoush Savadi-oskouei<sup>1</sup>, Mehdi Farhoudi<sup>1</sup>, Yaser Sharafi<sup>1</sup>, Homayoun Sadeghi-Bazargani<sup>2,3\*</sup><sup>1</sup>Neuroscience Research Center, Tabriz University of medical sciences, Tabriz, Iran<sup>2</sup>Traffic Injury Prevention Research Center, Department of Statistics & Epidemiology, Tabriz University of Medical Sciences, Tabriz, Iran<sup>3</sup> WHO Collaborating Centre on Community Safety Promotion, Karolinska Institute, Stockholm, SwedenEmail: [homayoun.sadeghi@swedensp.se](mailto:homayoun.sadeghi@swedensp.se)

**Abstract:** The aim of this study was to investigate whether Transcranial Doppler (TCD) findings can predict the short-term stroke prognosis jointly with the medical history, clinical and other imaging measures. A prospective cohort study was conducted on ischemic stroke patients during 2006-2007. TCD was performed for all the patients during the first 48 hours of admission. Unified form for Neurological Stroke Scales (UNSS) was completed for all eligible patients once at baseline then six months later. The score of this scale after six months was used as a surrogate measure of short-term prognosis. Data were analyzed using multivariate linear regression model. Mean (SD) of age among the patients was about 62(12) years. Seventy-two percent of 104 participants were males. Right hemiplegia was the most common chief complaint constituting 45 percent of subjects followed by left hemiplegia in 29 percent. Overall abnormal TCD findings were observed in 49 percent of patients. Mean(SD) of UNSS score was 43.3(8.2) at admission time and it improved to 51.6(6.4). The findings multivariate analysis indicated that baseline TCD findings could be used to predict functional prognosis in stroke patients six months after stroke attack. It was found that MCA involvement in both sides and right sided ACA involvement were the predictors of stroke prognosis independent of the patients' baseline status. Short-term stroke prognosis can be predicted by MCA and ACA involvement in TCD. But primary UNSS score at hospitalization time can predict short term stroke prognosis better than TCD findings.

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**Key words:** Transcranial Doppler; Prognosis; Stroke

**Introduction:**

Stroke is estimated to account for 6.2% of the total burden of diseases in 2020.[1] intracranial large-artery stenosis is considered as a common vascular lesion among people from different parts of the world especially those from an Asian, African, or Hispanic ancestry.[2] Due to substantially longer period of disease course in ischemic stroke it is of importance to have some reliable measures in order to predict the disease prognosis in short or long run. Various scales have been used to assess stroke prognosis and the scores of such scales can modeled to be predicted using clinical and neuroimaging measurements. TCD is an affordable, easy to be performed at bedside, and has also some other advantages that makes it an ideal tool for studying dynamic cerebrovascular responses.[3] TCD is both a diagnostic tool in stroke and has been used in stroke risk prediction[4-7]. However, the knowledge in this field is yet limited especially considering the variability in TCD findings from different parts of the world The aim of this study was to investigate whether Transcranial Doppler(TCD) findings can predict the short-term stroke prognosis jointly with the medical history, clinical and other imaging measures.

**Methods:**

A prospective cohort study was conducted during 2006-2007 in Razi University hospital in Tabriz, Iran. Of the 114 patients with ischemic stroke admitted to Razi University hospital 104 eligible cases were enrolled and investigated in this study. The exclusion criteria were:

- 1- Previous history of ischemic cerebrovascular accident
- 2- Comorbidities preventing to perform early TCD
- 3- Pregnancy
- 4- Poor window
- 5- Fevral disease during the first week of admission
- 6- Death during the first six months of the study

All the patients were examined by neurologist and past medical history was taken. Basic laboratory examinations and imaging were done. TCD was performed for all the patients during the first 48 hours of admission. Unified form for Neurological Stroke Scales(UNSS) was completed for all eligible patients once at baseline then six months later. The score of this scale after six months was used as a surrogate measure of short-term prognosis.

Data were analyzed using STATA version 11 statistical software package (STATA Corp. LP, College station, TX 77845, USA). Both descriptive and bivariate statistics were calculated at primary phase of analysis. To assess independent predictors of prognosis multivariate linear regression was later used. Ordinary linear regression analysis was used to model possible predictors of stroke prognosis while controlling for possible confounding effect of age and gender. Due to power limitations and to prevent expected multicollinearity, regarding TCD findings, categorical variables indicating if a vessel has abnormal TCD findings were modeled instead of exact continuous TCD measurements. To ensure statistical appropriateness of fitted models several measures were undertaken as follows: Outliers, leverage points and influential observations were investigated after fitting regression models. Homogeneity of residuals was checked using Breusch-Pagan test. Variance inflation factor was used to assess possibility of multicollinearity. Based on these checkups, only one generally acceptable model was fitted to predict UNSS six month score. Three observations with high leverage were also removed which led to exclusion of a primarily significant variable that assessed blood flow reversing. To make comparable the prediction coefficients of different variables with each other, standardized beta coefficients were estimated in regression model. The study was approved as a thesis for degree of specialty in neurology and received ethical approval from the committee of ethics in Tabriz University of medical sciences.

### Results:

A total of 104 observations were analyzed. Mean (SD) of age among the patients was about 62(12) years. Seventy-two percent of 104 participants were males. Table 1 summarizes the past medical history findings of the patients.

Table 1: Assessments in medical history of study participants

	Response	Number	Percent
Smoker	Yes	42	40.38
	No	62	59.62
Alcohol	Yes	6	5.77
	No	98	94.23
Opiate	Yes	5	4.81
	No	99	95.19
Hypertension	Yes	58	55.77
	No	46	44.23
Hyperlipidemia	Yes	27	25.96
	No	77	74.04
Ischemic heart disease	Yes	16	15.38
	No	88	84.62
Diabetes mellitus	Yes	25	24.04
	No	79	75.96

More than 95 percent of the patients were awake in consciousness assessment and only five of them were a bit lethargic. No pathologic finding was found in brain CT scan in 36 percent of the patients. Right hemiplegia was the most common chief complaint constituting 45 percent of subjects followed by left hemiplegia in 29 percent and dizziness was the third common chief complaint comprising nearly 10 percent of the patients. Laboratory measurements of the patients are summarized in table 2.

Table 2: Some laboratory findings of patients

Measurement	Mean	Standard deviation
Hb	14.8	1.8
Hct	44.3	5
BUN	22	11.6
Cr	1	0.4
TG	155.5	54.7
Chol	192.3	38.6
HDL	53.3	12.6
LDL	111	32.8
FBS	114.8	49.4
PT	13.3	2.3
PTT	34.6	10

Seventy percent of patients received aspirin, 30 percent received warfarin and 95 percent received heparin as treatment. PSVs for different vessels are plotted in figure 1. In this figure medians, 1<sup>st</sup> quartiles, 3<sup>rd</sup> quartiles and presence of outliers are compared for males and females.

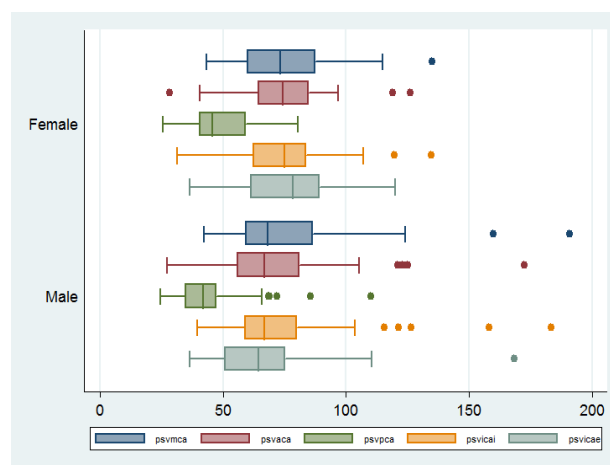


Figure 1: Box-plots of PSV for different vessels compared between males and females.

Overall abnormal TCD findings were observed in 49 percent of patients. This figure was 44.6 percent in males and 60 percent among the women but the difference was not statistically significant. Distribution of patients with abnormal TCD findings in each of the vessels are given in table 3.

Table 3: TCD abnormal findings in different cranial vessels

	Right side (%)	Left side (%)	Both sides (%)	Normal (%)
MCA	14.4	16.3	1	68.3
ACA	4.8	2.9	0	92.3
PCA	0	1.9	0	98.1
ICAe	1.9	3.8	1	93.3
ICAi	2.9	3.8	0	93.3
Siphone	1	1	1	97

Mean(SD) of UNSS score was 43.3(8.2) at admission time and it improved to 51.6(6.4). The difference was statistically significant ( $P<0.001$ ).

Multivariate analysis revealed some TCD findings along with baseline UNSS score to be

associated with six month prognosis of non-mortal ischemic stroke. This final model could explain up to 70 percent of variation in outcome variable. Table 4 provides raw and standardized beta coefficients of the variables.

Table 4: Multivariate linear regression model characteristics

	$\beta$ coefficient	Standardized $\beta$ coefficient	P value
Baseline UNSS	0.49	0.62	<0.001
Left sided MCA involvement	-5.5	-0.34	<0.001
Right sided MCA involvement	-4.3	-0.24	<0.001
Right sided ACA involvement	-3.7	-0.14	<0.05
Outcome variable: UNSS 6 <sup>th</sup> month score			
Model constant: 32.8 ( $P<0.001$ ) - R-squared =0.7			

## Discussion

To assess the stroke functional prognosis we have used UNSS. UNSS has been widely used to assess stroke prognosis in prognostic studies or in assessing efficacy of treatments in stroke clinical trials[8-18]. It has been shown to be valid and reliable both in ischemic and hemorrhagic stroke patients[8,9]. However, other tools have also been used. TCD is both a diagnostic tool in stroke and has been used in stroke risk prediction[4-7].

The findings of the present study indicated that baseline TCD findings could be used to predict functional prognosis in stroke patients six months after the stroke attack. This was, in general, consistent with some previous research[3,19]. Although as could be found from standardized betas of multivariate regression analysis in this study, baseline UNSS score appeared to have better predictive power than TCD related predictors, it was found that 70% of the outcome variability could be predicted jointly by UNSS score and TCD findings being regarded to be relatively high. Baseline stroke severity has consistently been included in prognostic models of stroke prognosis[10]. Similarly with our findings, it has previously been shown that vasomotor reactivity in patients with acute stroke who have extracranial and intracranial artery stenosis measured by using a transcranial Doppler examination, may have value in predicting long-term outcome[20].

The present study found that MCA involvement in both sides and right sided ACA involvement were the predictors of stroke prognosis independent of the patients' baseline status. It has been reported by previous research also that MCA occlusion

may be associated with a higher fatality and also the patients with patent MCA may be more likely to clinically improve within 4 days than patients with MCA occlusion[21]. Despite some inconsistencies in existing literature, it has been demonstrated the age, initial severity of stroke, and lesion location as predictors of functional outcome[10].

TCD is not the sole imaging method used to assess stroke morbidity, and other modalities have also been used including ; Computed tomography (CT), magnetic resonance imaging (MRI), xenon-blood-flow, positron emission tomography (PET), cerebral angiography, magnetic resonance angiography (MRA), echocardiography and Holter monitoring[22]. However, it is the only noninvasive examination method that enables the reliable evaluation of blood flow from the basal intracerebral vessels, adding physiologic information to the anatomic images. As confirmed in this study regarding its power to predict the functional prognosis of stroke, also considering its known advantages as stated above and its reasonable costs and convenient use at bedside, makes it ideal for studying disease behavior among stroke patients[3].

## Conclusion:

Short-term stroke prognosis can be predicted by MCA and ACA involvement in TCD. But primary UNSS score at hospitalization time can predict short term stroke prognosis better than TCD findings.

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